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THE PHYSIOLOGICAL PAPERS OF PROF. SACHS.

Gesammelte Abhandlungen über Pflanzen-physiologie. Von Julius Sachs. 2 vols., with 126 woodcuts and 10 plates. (Leipzig, 1892-3.)

THIS excellent collected edition of Prof. Sachs's chief contributions to the physiology of plants will be welcome to all botanists. The author in his preface explains the very sufficient reasons which have led him to publish this collection, and the principles which have guided him in the choice of papers. He has not thought it necessary to reproduce all his physiological treatises, but has more especially aimed at selecting such as deal with matters of fact rather than theory, while some which he considers to be sufficiently well known already are omitted.

Such a collection is a great help to the reader, and especially so when it is compiled by the author himself. In this case we do not merely obtain a series of isolated papers, but have the further advantage of learning the author's mature view of the relative importance of his own researches.

Many of the papers have been abridged, and some are only given in abstract. In many cases notes have been added, which are not the least interesting part of the work, as they often indicate the author's latest views on the questions at issue.

To review adequately a collection of Prof. Sachs's physiological treatises would be to write the history of vegetable physiology from 1859 onwards. Such an attempt is out of the question; only a very short sketch of the contents of this book can be given here.

The selected papers, 43 in number, are arranged, according to subject, in nine groups; within each group the order observed is chronological. The first volume contains works concerned chiefly with the chemical and physical phenomena of vegetation, while those contained in the second volume are on growth, cell-formation, and irritability.

The first section contains essays on the action of heat on plants. The first, published in 1860, is on the effects of frost. The observations described will be remembered by all readers of Prof. Sachs's text-book. There is much room for further research on the effects of low temperatures on various plants, and the subject is obviously of practical as well as of physiological interest.

Other papers in this group are on the dependence of germination on temperature, on transitory rigidity in irritable organs, on the superior limit of temperature as affecting vegetation, and on the influence of temperature on the formation of chlorophyll. All these investigations are of fundamental importance; the same perhaps can scarcely be said of the last paper in this part, "On Emulsion Figures and the Grouping of Swarm-spores in Water," which is merely concerned with a possible source of error in observations on the movements of unicellular organisms.

The succeeding section, on the action of light on plants, includes some of the best known of the author's researches, the most important perhaps being that on the effect of light of different colours on assimilation and growth. It is a little disappointing, however, to find no reference in the notes to the more recent and exact work of Timiriazeff, Engelmann, and others. The latest published paper in this section, "On the Action of the Ultra-violet Rays on the Formation of Flowers" (1883 and 1886), is probably less familiar to physiologists than the others. In this, Prof. Sachs brings forward evidence to show that when, in the case of a green plant, the ultra-violet rays alone are excluded, the development of flowers is hindered, though otherwise the plant grows normally. The conclusion which he arrives at is that the ultra-violet rays produce, in the green leaves, the "flower-forming substances."

The third group of papers, on chlorophyll and assimilation, is certainly among the most important in the collection, for by means of these researches the author first proved that the chlorophyll corpuscle is the organ of assimilation, a fact which forms the basis of the whole physiology of nutrition in plants. The investigations, dating from 1862, by which Prof. Sachs showed that starch appears in the chlorophyll corpuscles as a result (though, as we now know, not an *immediate* result) of assimilation, are of special interest at the present moment, in view of the new light recently thrown on this whole subject by the work of Messrs. Brown and Morris.

Later papers in the same section are those "On the Activity of Nutrition in Leaves" (1884), and on "The Treatment of Chlorotic Plants" (1888). The former is devoted chiefly to the determination of the energy of assimilation in the leaves of various plants. The latter is the only paper in the collection written with a "purely practical" object, namely to teach the most convenient and effective method of applying iron salts as manure to plants which, from want of iron, fail to develope their chlorophyll.

The fourth section includes the work on the movements of water in plants. Among other researches of importance, we here find the well-known treatises "On the Ascending Current of Sap in Transpiring Plants" (1877-8) and "On the Porosity of Wood" (1877-9). The former contains the author's classical determinations of the rate of ascent of the sap, by means of the Lithium spectroscopic method, while in the latter his famous "imbibition theory," according to which the water rises in the substance of the lignified cell-walls, is developed. This theory is no longer accepted by physiologists, but the author justly points out that the facts given in the paper maintain their value quite independently of the truth of his theoretical conclusions.

The papers of the fifth group, on the behaviour of the constructive materials during growth, are all of early date (1859-63), and the author regards their interest as being mainly historical. To us they seem to be among the most attractive in the collection. Most of them relate to the phenomena of germination, and especially to the changes undergone, during that period, by the reserve food substances, while many facts of morphological and histological interest are also told us.

Going on to the second volume, we find in the sixth section of the work the author's researches on the subject of growth, which he carried out with the help of the various forms of auxanometer invented by him. His results, which first established the extreme complexity of the conditions on which the rate of growth in plants depends, are familiar to readers of his text-book and lectures.

The seventh section contains the papers on "tropisms," *i.e.* the reactions of growing organs under the stimuli of gravitation, light, and moisture. The last paper in the group, that on orthotropous and plagiotropous organs, seems to us to be of the widest interest, as offering a contribution towards the solution of the most fundamental and most difficult of all biological problems, namely the question of the *causes* of the forms of organisms. This in the author's phrase is the problem of "scientific morphology."

Section VIII., on the relations between cell-formation and growth, includes the two well-known papers on the arrangement of cells (1878–9) in which the form of the network of cell-walls is explained with the help of the law of their rectangular intersection. The author shows how, in organs of similar outline, identical arrangements of the cells arise, whatever may be the morphological nature of the organ, so that the cellular structure of a hair, an antheridium, and an embryo may be the same. He has thus given a useful warning to morphologists, who have often laid too much stress on mere cell-arrangement in discussing embryological and other similar questions.

The last paper in this section is on "Energids and Cells." As it is the most recent of all (1892), and probably the only one in the book which may not yet be familiar to botanical readers, a short account of its contents may be useful.

Under the term *energid*, Prof. Sachs understands a single nucleus, together with the protoplasm governed by it, the two together forming a whole, which is an organic unit, both in the morphological and physiological sense. He has chosen the name energid in order to express the chief property of the organic unit, namely, that it possesses internal or vital energy. The conception of an energid, as distinct from that of a cell, has become necessary, owing to the discovery in recent years of so many multinucleate cells and multinucleate organisms without cellular structure, discoveries which we chiefly owe to the researches of Schmitz. Such a multinucleate cell or organism, though enclosed within the contour of a single cell-wall, is manifestly equivalent not to a single uninucleate cell, but to a multicellular structure. This is proved by the fact that the portions of protoplasm, each surrounding a nucleus, so often subsequently become free as complete and independent cells, as in the formation of the zoospores of *Saprolegnia*, or form a multicellular tissue, as in the endosperm of many Phanerogams.

It is quite evident that the word *cell* has come to be used in many different and inconsistent senses. As Prof. Sachs says: "According to the prevailing terminology, an empty wood fibre is a cell, so is an embryo-sac containing young endosperm, and so also is an Amœba, or a zoospore, or even an entire Caulerpa." Everyone who has had to teach botany will sympathise with the author in his complaints of the confusion thus caused. While other sciences keep their technical language up to date, "the science of living things begins with a word which arose more than 200 years ago in consequence of a mistake." Hence, in his opinion, a radical change in language is demanded; for the true histological unit the word *energid* is proposed, while the old word *cell* can be retained, either for the cell-wall alone (its original sense), or for the cell-wall together with its contents, whatever they may be, and whether including one energid or many.

It appears to us that the change proposed is a real and great improvement; the only difficulty is our firmly fixed habit of connecting the idea of a histological unit with the word *cell*. Whether the new term be adopted or not, Prof. Sachs has done good service in bringing clearly before us the contradictions between our present antiquated phraseology and histological facts as they are now known to us.

The ninth and last section of the work is on the causal relations of the form of plants. It consists mainly of the two essays on "*Stoff und Form*," which have already attracted much attention, and met with much criticism. The fundamental conception on which these essays are based, is the idea that the organs of plants owe their form to their substance, just as a crystal owes its form to the chemical constitution of its molecules. Prof. Sachs, therefore, believes that there must be a special substance concerned in the formation of each kind of organ; there must be a root-forming substance, a shoot-forming substance, a flower-forming substance, and so on. Of course the quantity of the active substance by which form is determined may be extremely small in comparison with the whole material of which the organ consists. Prof. Sachs supposes that these hypothetical formative substances are, in the case of green plants, produced in the assimilating organs, and thence conveyed to the seats of developmental activity. He is inclined to identify the formative substance with the *nucleine*, and is so far in agreement with many modern histologists. He regards the different specific formative substances as being possibly varieties of nucleine, comparable to the isomers of grape-sugar, or of tartaric acid.

The extremely hypothetical character of the whole theory is manifest. There is at present no evidence for the existence of specific formative (*e.g.* "root-forming" or "shoot-forming") substances. Even if we accept nucleine as representing them, we still have no evidence that it is formed in the assimilating organs, or indeed that it exists, as such, anywhere except in the nucleus itself. So far as we know at present it seems that the nucleus forms the nucleine, not the nucleine the nucleus. Until some basis of fact is found for the "*Stoff und Form*" hypothesis, it can only be regarded as a formal, not a real explanation of the phenomena, however valuable it may be as a stimulus to further enquiry.

An addendum to the last paper gives an extract from the Lectures on the Physiology of Plants (1st edition, 1882), on the continuity of the embryonic substance. It certainly seems to us that Prof. Sachs' idea here expressed is essentially the same as the conception of the continuity of the germ-plasm, which has played so important a part in recent biology. The form in which the doctrine is put by Prof. Sachs is specially applicable to plants, in which the continuity of the germ-plasm can only be traced through the embryonic substance of the growing points.

This collection, containing what are probably the most important contributions of our time to the physiology of plants, is in itself a marvellous record of scientific activity. As Prof. Sachs is still engaged in physiological research, we may hope that a later edition of the work will contain many further invaluable additions to our knowledge.

D. H. S.

OUR BOOK SHELF.

On English Lagoons. By P. H. Emerson. (London: David Nutt, 1893.)

YET another book about the Norfolk Broads, or, as the author prefers to call them, the "English Lagoons." One can hardly credit that anything fresh could be said on this well-worn subject, but Mr. Emerson's book differs from all that have gone before in being a continuous narrative of a twelve months' sojourn on the Broads in his pleasure wherry, the *Maid of the Mist*, and presents to us a graphic picture of these waters under their winter aspect as well as under a summer sky. Much that he has written, more particularly his excellent descriptions of the peculiar scenery of this remarkable admixture of land and water in mid-winter, is highly interesting. The atmospheric effects under various conditions of storm and sunshine, by moonlight and at early dawn, display a keen artistic perception, but the incidents as a rule are trivial in the extreme in fact, and the constant use of the vernacular becomes tiring—whole chapters (*e.g.* Chapter xxi. of six pages) might have been well omitted.

From a naturalist's point of view the reader cannot fail to be pleased with the kindly spirit which pervades the book, the evident delight which the author took in his feathered friends, and his disgust for the wanton destruction which is too frequently committed by thoughtless visitors to these delightful retreats, but having said this we confess we are rather puzzled by Mr. Emerson's ornithology. On page 216, for instance, he mentions watching a pair of desert wheatears on Palling Sand Hills; surely he cannot have met with *Saxicola deserti* in Norfolk. Scarcely less astonishing is the mention of a blue-headed wagtail's nest, and the appearance of the white wagtail on several occasions. The present writer has known the Broads for forty years, but has never had the good fortune to meet with *Motacilla flava* or *M. alba*, both of which are excessively rare in Norfolk, and probably only occasionally appear as passing spring migrants. Many of the observations on birds are interesting, but the following passage is hardly in good taste. Speaking of Surlingham Broad, "which the late Mr. Stevenson, the local naturalist, loved," Mr. Emerson continues, "But this piece of water is to me dull and songless, but then Mr. Stevenson did not know shadows from reflections, nor, I suspect, beauties from commonplaces. As a naturalist, moreover, he was not to be compared to the late Mr. Booth, a true lover of birds and of outdoor life. But in Norfolk every native goose is a swan." Mr. Stevenson's reputation as an ornithologist is too well established to need any defence from my pen, but I can say without hesitation that the best general description of the Broad district ever written is to be found in the introduction to his "Birds of Norfolk," and his chapters descriptive of a summer's night and a summer's day on the very Broad which Mr. Emerson considers so uninteresting, show not only his wonderful powers of observation but his keen perception of the beauty and poetry of nature; even so familiar a bird as the redbreast is invested with fresh interest after reading his charming chapter on this pert little friend of man.

T. S.

The Mechanics of Architecture. By E. Wyndham Tarn, M.A. (Crosby Lockwood and Son, 1892.)

THE modern architect is beginning to perceive that he has allowed the engineer to cover the ground with monstrosities because his immediate predecessors considered that any scientific knowledge would spoil the artistic faculty, regardless of the great architects of the past, Sir Christopher Wren, Leonardo da Vinci, and the designers of our cathedrals.

The theories which the author discusses, as of Pillars, Roofs, Arches, Domes, and Spires, Buttresses and Foundations, are illustrated by numerical applications to well-chosen existing examples; so that the architect will thereby acquire confidence in the formulas, and not lay himself open to disaster in consequence of a mathematical misprint.

Graphical constructions are freely employed, which recommend themselves to the draughtsman, who thinks better on his drawing-board than in symbols and formulas.

G.

LETTERS TO THE EDITOR.

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Telegony.

THIS is a term which Prof. Weismann has recently coined to designate a class of phenomena which have thus far been pretty generally accepted as of unquestionable occurrence in mammals, if not also in birds. I refer to the alleged influence of a previous sire on the progeny of a subsequent one by the same mother. The most notorious instance of this alleged fact is that of Lord Morton's Arabian chestnut mare, which had her first foal to a quagga. Subsequently she produced two colts by a black Arabian horse. These were both partially dun-coloured, and striped on the legs more plainly than the real hybrid had been. One of the colts was also striped on the neck and some other parts of the body; lastly, the mane in both resembled that of the quagga, being short, stiff, and upright. Darwin, from whom this description is taken, records an almost exactly parallel case, on the authority of Mr. James Weir. He also gives a number of references to other cases, not only in horses, but likewise in sheep, swine, dogs, &c. Within the last twelvemonth another seemingly unmistakable case of the same thing took place in the Zoological Gardens, and is recorded by Mr. Tegetmeier in one of the December numbers of the *Field*. Here the first foal was a hybrid between two species of ass, and the second by a male of the same species as the mother. Not a few further apparently well-authenticated instances might be mentioned, but these are enough for present purposes. Indeed, most breeders and fanciers are so persuaded of the truth of "telegony" as to deem a pedigree animal seriously deteriorated in value if she has been covered by an inferior male, while in Darwin's opinion "there can be no doubt" as to the fact of this influence of a previous sire being occasionally exhibited in mammals, although he expresses himself as doubtful with regard to it in the case of birds.

Prof. Weismann, however, has recently challenged the facts. He has also given his explanation of them, supposing them to be facts. Therefore I will consider these two points separately.

Several years ago I undertook an experimental inquiry upon the subject with dogs, which yielded negative results. I then obtained an introduction to Mr. Everet Millais, in order to profit by his large experience and scientific interest in all matters pertaining to dog-breeding. He suggested that the question ought to be put in the journals of fanciers in this country, and also in America, for the purpose of raising discussions upon it. This was done, with the result of letting loose floods of letters to